California MEDICINE

OFFICIAL JOURNAL OF THE CALIFORNIA MEDICAL ASSOCIATION

Volume 86 APRIL 1957 Number 4

Preoperative Pulmonary Evaluation

As Viewed by the Internist

THEODORE L. BADGER, *M.D.*, Boston

• **The internist as well as the surgeon finds thorough pulmonary functional evaluation of the patient for operation an invaluable adjunct to strictly clinical judgment in two large categories of patients: Those with significant inconsistencies between clinical impression and functional analysis of pulmonary reserve as well as in those with borderline functional reserve where operation is imperative.**

PREOPERATIVE PULMONARY EVALUATION for appraisal of surgical risk may require more careful analysis than a clinical impression. It need hardly be mentioned that evaluation of the patient for elective operation is quite different from evaluation for emergency intervention. In emergency, time is a factor that cannot be neglected. The preoperative revelations of a chest x-ray in addition to the stethoscope, the electrocardiographic contributions to auscultation of the heart, a urine examination, hematocrit determination and examination of a specimen of blood, blood grouping and determination of nonprotein nitrogen, sugar content and carbon dioxide combining power may be all one needs to be prepared to cope with most complications that may develop.

Emergency operations upon the thorax and the thoracic organs are rather uncommon except following severe trauma. Most emergency thoracic procedures come at a time when function has already been seriously impaired and operation must be expected to improve rather than diminish function further. This is true in patients with ruptured emphysematous blebs and tension pneumothorax; it is true in cases of chest trauma, in patients with rupture of the esophagus; and it is true even when operation is done to stop bleeding. In such cases the patient has already survived a severe trial of pulmonary insufficiency and in these situations operation can be performed even if objectively evaluated pulmonary reserve proves to be well below the acceptable minimum of reserve ordinarily required for transthoracic operation.

This communication is concerned with pulmonary evaluation for elective operations, principally to screen out patients unfit for operation because of pulmonary insufficiency. It should be clearly stated, however, that this evaluation of pulmonary reserve reflects the thoughts of an internist and chest physician, not those of a pulmonary physiologist. Its purpose is to depict the clinical usefulness of the findings of the pulmonary function laboratory. The de-

Assistant Clinical Professor of Medicine, Harvard Medical School.

Presented before the Sections on General Medicine and General Surgery at the 85th Annual Session of the California Medical Association, Los Angeles, April 29 to May 2, 1956.

From the Thorndike Memorial Laboratory and the Second and Fourth (Harvard) Medical Services, Boston City Hospital, and the Department of Medicine, Harvard Medical School.

This study was supported in part by research grant (H1773) from the National Institutes of Health, Public Health Service, and the Committee on Medical Research, American Trudeau Society, Medical Section of the National Tuberculosis Association.

tailed pulmonary function studies in the cases here reported upon were done under the direction of Dr. Edward A. Gaensler with his associates, Dr. Asher Marks, Dr. Inga Lindgren, Dr. John B. Cadigan, Jr. and formerly Dr. David W. Cugell, in the Pulmonary Physiology Laboratories of the Boston Sanatorium and the Boston City Hospital. The usefulness of these studies to the internist, in his evaluation of surgical risk, is the purpose of this paper.

Clinical evaluation is an inseparable component of preoperative evaluation but objective physiologic studies have come to play an increasingly important part in one's judgment of pulmonary reserve.

PRELIMINARY SCREENING

Many times when a thoracic operation is contemplated, elaborate lung function studies are neither available nor necessary. Initial screening tests for pulmonary reserve can be those of the clinician in the examining room of his office or the hospital. It should be a function of the pulmonary physiology laboratory to contribute to the diagnostic acumen and the facilities of the clinician by the adaptation of function tests for office use. Use of the fluoroscope, with its view of the dynamic action of the heart, the lungs and the thorax, should supplement the history of symptoms and the physical examination, for it can contribute considerable accuracy in the estimation of pulmonary reserve. A searching history and complete physical examination are background data for careful surgeons. It is not always possible historically, to separate the symptoms of primary pulmonary origin from those secondary to cardiac disease, so closely interdependent are these two systems. The following symptomatic information may be revealing:

1. *Signs and Symptoms of Pulmonary Origin:*
   - Breathlessness (1 or 2 flights)
   - Cough (character)
   - Sputum (amount and character)
   - Hemoptysis without pleurisy
   - Wheezing
   - Previous chest plates
   - Dyspnea without orthopnea
   - Known pulmonary disease
   - Previous chest surgery
   - Asthma and other allergies
   - Chest pain (character)
   - Occupation, familial pulmonary disease.
2. *Signs and Symptoms of Cardiovascular Origin:*
   - Known cardiac disease
   - Rheumatic state
   - Family or personal embolic history
   - Orthopnea, precordial pain with effort
   - Paroxysmal nocturnal dyspnea
   - Peripheral and sacral edema
   - Previous electrocardiograms
   - Fatigue and limitation of activity
   - Palpitation and irregularities of cardiac origin.

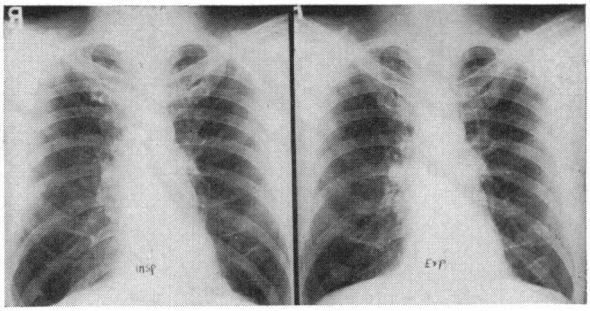

Figure 1 (Case 1).—*Left:* Inspiration. *Right:* Expiration, with diaphragms equivalent to 4.5 cm. higher than on inspiration, smoother and more rounded. Not shown was the very slow movement of 9.0 seconds by fluoroscopy to acquire this degree of elevation.

Specific factual data from pulmonary observations should be added to this historical framework. A stethoscope, the use of which is understood, a tape measure, a flight of stairs, a watch, a skin pencil and a few x-ray films of the chest will enable the clinician to screen out the pulmonary sufficient from the insufficient. As adjuncts to keen clinical observation, the fluoroscope and a timed vital capacity machine for measuring breathing performance in volume per unit of time are the two most useful pieces of screening apparatus for the office. Roentgenologists are not accustomed to report the type of information that is useful to the clinician for the determination of obstructive and restrictive defects in breathing. Fluoroscopy by the clinician should be reserved primarily for observing the dynamic action of the thoracic organs within the chest, as well as their silhouettes. The x-ray examination of the lungs should be relied on only for the detection and analysis of parenchymal disease. Definitive x-ray observations should complement fluoroscopy and the physical examination. The following observations which have proved most essential for preliminary screening and evaluation of lung function are based upon my personal experience with 350 fluoroscopic examinations in the office:

Fluoroscopic Screening for Lung Function

1. Chest wall—expansion in diagonal view, marked and measured on screen in centimeters.
2. Heart and vessels—position, silhouette, pulsations.
3. Diaphragms:
   (a) Position—at posterior ribs.
   (b) Equality or differences in action.
   (c) Maximum excursion—marked on screen and measured in centimeters.
   (d) Speed of excursion—fast or slow—but timed for maximal rise.
4. Lungs:
   (a) Comparative radiance.
   (b) Abnormal shadows—fluid—free air.
   (c) Trapping of air—unusual localized radiance at end of expiration and mediastinal motion.

The timed vital capacity machine devised by Gaensler[2] in our laboratories is a simple vital ca-

pacity machine with an electronic timing device for measuring the volume of air exhaled in the first, the first two or the first three seconds of the maximal expiratory effort in addition to the total vital capacity. Normal persons exhale 75 to 90 per cent of their total vital capacity in one second and 90 to 100 per cent in three seconds. Persons with obstructions to the flow of air out of the lungs may, for example, exhale only 25 to 60 per cent of their total vital capacity in the first second. On the contrary, persons with pulmonary fibrosis or other restrictive parenchymal lesions without airway obstruction and those with muscular weakness or paralysis or lack of "driving power" may have a reduced or restricted total vital capacity but may exhale a normal or greater than normal per cent of that volume in one second.

The following case is illustrative of the usefulness of these pulmonary screening examinations.

CASE 1. The patient was a 50-year-old administrator with a family history of four generations of severe shortness of breath consistent with emphysema. His own difficulties in breathing were of six years' duration, slowly and progressively becoming worse. He was a tall, well-built active man with dusky lips who was obviously short of breath at rest.

The results of office examination and functional evaluation were as follows:

Lungs: Hyper-resonant—clear—breath sounds faint.
Fluoroscopy: Chest expansion 1 cm.—radiant++.
Diaphragms: Twelfth rib—maximal excursion 4.5 cm. Paradoxical in motion at onset of inspiration and expiration—speed of expiration 9.0 seconds.
Heart: Small—pulmonary conus prominent
Vital Capacity: 4,200 cc., 100 per cent of predicted normal.
Timed Vital Capacity: 36 per cent of total vital capacity in 1 second.
Conclusion: Advanced pulmonary emphysema.

These findings, entirely consistent with advanced emphysema, were confirmed by more detailed study for specific problems of therapy.

The inspiratory and expiratory x-ray films of the chest (Figure 1) showed the low diaphragm with very little difference in the two positions. The x-ray silhouette showed a prominence of the pulmonary conus in the right anterior diagonal view, typical of cor pulmonale (Figure 2).

Thus, the history, the office examination, fluoroscopy and timed vital capacity gave a clear-cut picture of the severity of disease. Also illustrated was the well known fact that determination of the vital capacity alone is of little value. On the contrary, for preoperative evaluation, reliance on this "objective" test alone may lead to disastrous consequences. In this man with dyspnea at rest and far advanced emphysema, the vital capacity was 100 per cent of normal.

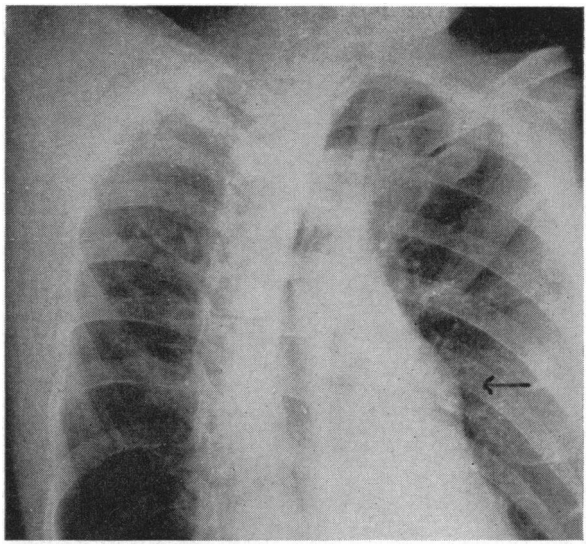

Figure 2 (Case 1).—Right anterior diagonal view of patient in Figure 1, showing considerable prominence of pulmonary conus, from increased pulmonary arterial pressure in advanced obstructive emphysema.

It is not necessary to explore all techniques of preoperative pulmonary evaluation beyond these preliminary office screening procedures, but there are specific indications for special and thorough investigation of pulmonary reserve,[9] as follows:

Indications for Special Function Studies

1. Inconsistencies between the clinical impression and screening functional analysis of pulmonary reserve.[3]
2. Dyspnea not explained by x-ray films or routine function studies.
3. Borderline functional reserve where operation is imperative, requiring differential bronchospirometry.[4]

Doubts or inconsistencies between the clinical impression of pulmonary reserve and preliminary screening functional tests should be a sound criterion for more elaborate and definitive studies of pulmonary function. The type of operation anticipated may be modified not only by the degree of pulmonary insufficiency but by the infringement of specific surgical procedures upon existing pulmonary reserve.[9]

Dyspnea not explained by the x-ray or preliminary screening studies is seen largely in patients with diffuse pulmonary lesions of varying severity as observed by x-ray, yet have essentially normal results of ventilatory studies. The process, widely disseminated in the alveolar membranes in certain granulomatous and fibrotic diseases of the lungs, is such as to effect the diffusion of gases in the so-called "alveolar-capillary block" syndrome described by Cournand.[1]

This complicated subject is not under discussion here, chiefly because such patients usually have dif-

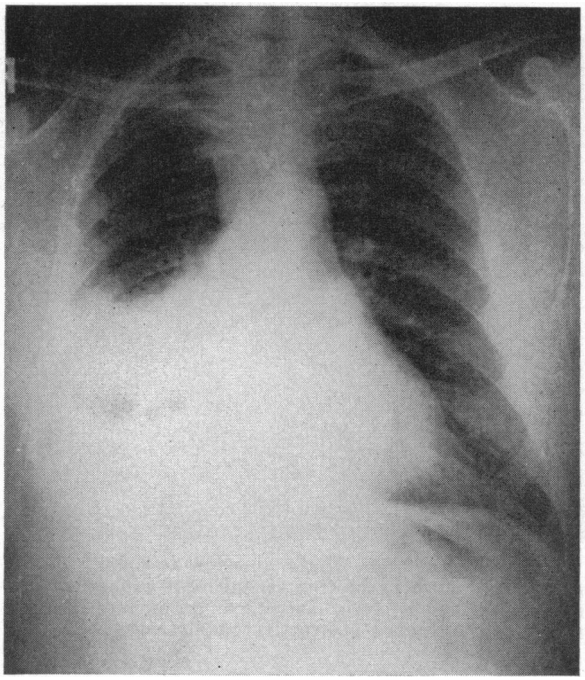

Figure 3 (Case 2).—Proved epidermoid carcinoma of right main stem bronchus. Left lung clear.

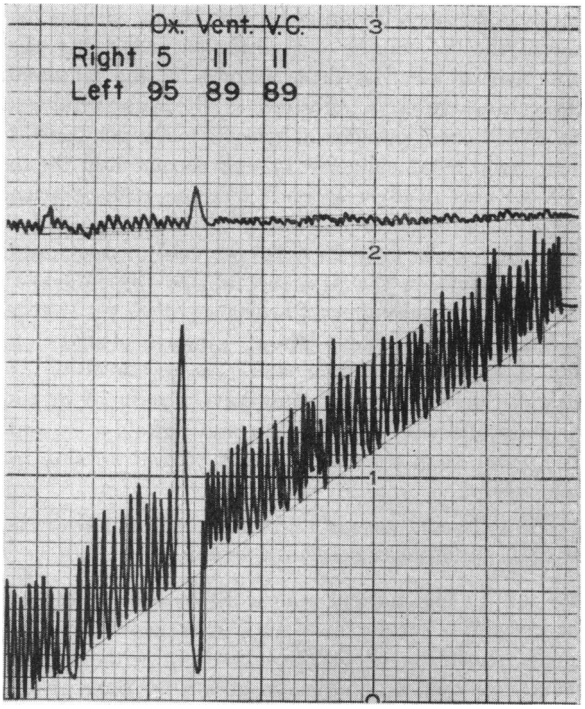

Figure 4 (Case 2).—Bronchospirometry shows almost complete dysfunction of the right lung (upper tracing) and normal function of the left. Prediction was satisfactory reserve on left to carry the whole load following right pneumonectomy. (Ox.=Oxygen uptake; Vent.=Ventilation; VC=Vital capacity—all expressed in per cent of total for both lungs.)

fuse rather than localized pulmonary disease and do not present surgical problems. Occasionally, a patient with old healed miliary tuberculosis and final localized disease may offer a problem with regard to oxygen transfer—in other words, may have an "alveolar-capillary block." Patients are occasionally referred to a thoracic surgeon for lung biopsy for definitive diagnosis or treatment on medicolegal problems. Severe "alveolar-capillary block" in these patients makes them a bad surgical risk for any intrathoracic procedure, including biopsy. This syndrome also offers a differential diagnostic problem in patients proposed for mitral valve operations who also have evidence of severe pulmonary infiltration. A few simple clinical findings which may point to the diagnosis of "alveolar-capillary block" may be mentioned here:

1. Evidence of diffuse miliary pulmonary infiltration on the x-ray film of the chest;
2. Normal maximal breathing and timed vital capacities;
3. Slightly to greatly reduced total vital capacity;
4. Respiratory alkalosis as evidenced by decreased carbon dioxide content and increased pH of the arterial blood; and, most important,
5. An increased dyspnea index or diminished breathing reserve due to increased ventilatory requirement rather than diminished breathing capacity.

Great discrepancies between the pulmonary function data and the patient's dyspnea are sometimes seen also in persons with neurocirculatory asthenia, in malingerers, and in persons with insurance claims.

Borderline functional reserve particularly deserves emphasis. Some thoracic surgeons still show a lack of interest—if not hostility—toward preoperative objective pulmonary functional evaluation. Some of them, discussing this subject, refer to an excellent operative record along with a low mortality rate due to pulmonary insufficiency as well as a low respiratory morbidity, as evidence in favor of clinical judgment only in the evaluation of surgical risks. Lacking, however, are data on the number and type of cases denied operation on the basis of clinical judgment only in estimating insufficient pulmonary reserve. On innumerable occasions Dr. Gaensler has carried out pulmonary function studies on patients of borderline risk who had been refused operation. It has been a matter of considerable interest that a number of them, after careful (and occasionally complex) testing, have been cleared for operation and have withstood the needed procedure without significant difficulty.

In considering inconsistencies between clinical impression and functional analysis of pulmonary reserve as well as borderline functional reserve when operation is imperative, the following cases are illustrative.

Case 2. The patient, a 59-year-old man with a proved epidermoid carcinoma of the right main

stem bronchus, had shortness of breath that had increased over an eight-month period and was out of proportion to other clinical observations. Right pneumonectomy was contemplated and it was imperative to know if the left lung could carry the respiratory burden alone, considering the degree of shortness of breath in the preliminary studies.

An x-ray film of the chest (Figure 3) showed the tumor mass in the right hilar region, supposedly some fluid (although none could be obtained) and a clear left lung.

Results of pulmonary ventilatory studies were:

	Predicted	Determined	Per Cent of Predicted
Maximal breathing capacity (liters per minute)	124	53	42
Vital capacity, cubic centimeters	3,995	2,100	52
One minute timed vital capacity, per cent of total	75	75	100
Air velocity index	1.0	0.80	....
Walking dyspnea index, per cent	15	45	....

The maximum breathing capacity was greatly reduced, but only slightly more than the vital capacity in per cent of predicted. Therefore, the air velocity index of 0.80 was nearly normal, indicating an absence of significant obstructive insufficiency. This was confirmed by the one-second timed vital capacity, which was normal. The walking dyspnea index showed that 45 per cent of the maximal breathing capacity (instead of a normal 20 per cent) was required during a leisurely walk at the rate of 180 feet per minute. Therefore, no obstructive defect was present.

The preliminary impression from the tests was of a moderately severe restrictive ventilatory insufficiency. Right pneumonectomy was considered possible provided the right lung did not contribute very much to total function.

Bronchospirometry for determination of the function of each lung separately showed that the right lung contributed only 5 per cent to the total oxygen uptake, 11 per cent to the ventilation and 11 per cent to the vital capacity (Figure 4). In other words, the patient already had, in physiologic effect, pneumonectomy of the right lung. It was thus determined that the left lung could carry the load alone and the patient was approved for right pneumonectomy.

CASE 3. The patient, a man 59 years of age, had had increasing shortness of breath over a period of five years. He had a proved carcinoma of the left main stem bronchus with wheezing cough and considerable mucoid sputum for three years. He appeared to be very short of breath but preliminary studies were not adequate for determining whether the right lung could carry the load if left pneumonectomy were performed.

An x-ray film of the chest (Figure 5) showed the tumor mass in the left hilum with lateral extension

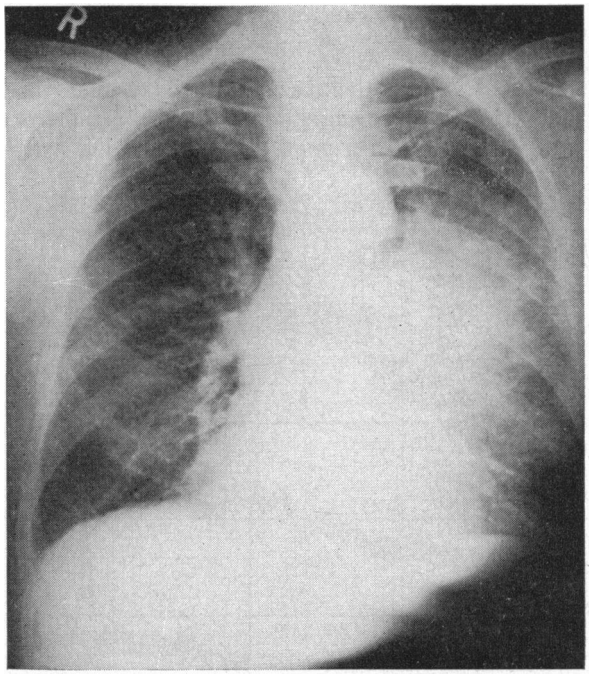

Figure 5 (Case 3).—Proved carcinoma of left main stem bronchus with lymphogenic spread through lung parenchyma. Right lung clear and not especially emphysematous in appearance.

of the process but not much evidence of atelectasis.

Results of pulmonary ventilatory studies were:

	Predicted	Determined	Per Cent of Predicted
Maximal breathing capacity (liters per minute)	119	36	32
Vital capacity, cubic centimeters	3,900	2,940	75
One minute timed vital capacity, per cent of total	75	35	47
Air velocity index	1.0	0.42	....
Walking dyspnea index, per cent	15	70	....

The maximal breathing capacity was reduced to one-third of normal and the vital capacity reduced to three-fourths of normal, thus giving a very low air velocity index of 0.42. This, together with severely reduced one-second timed vital capacity, indicated severe pulmonary insufficiency of the obstructive type. Functional incapacity in this case appeared to be due to advanced emphysema rather than to the carcinoma. Therefore, determination of individual lung performance was needed for final decision regarding the suitability of the patient for operation. Results of bronchospirometric studies (Figure 6) showed the right lung contributing a nearly normal share of function—43 per cent of oxygen uptake, 31 per cent of ventilation and 39 per cent of the vital capacity. It was clear that in the presence of this degree of obstructive emphysema the right lung could not carry the load alone after left pneumonectomy. Operation was not advised. Treatment with nitrogen mustard and x-ray therapy was

recommended and carried out with transient symptomatic relief.

CASE 4. The patient, a 26-year-old woman, had had therapeutic pneumothorax on the right from 1943 to 1948 with a good collapse, and left extrapleural pneumothorax from 1944 to 1947 for upper lobe cavitary disease. Attempted reexpansion of the right lung was not very successful and was followed by a tuberculous effusion. Two years after reexpansion of the left extrapleural pneumothorax, a new exudative lesion developed in the left upper lobe.

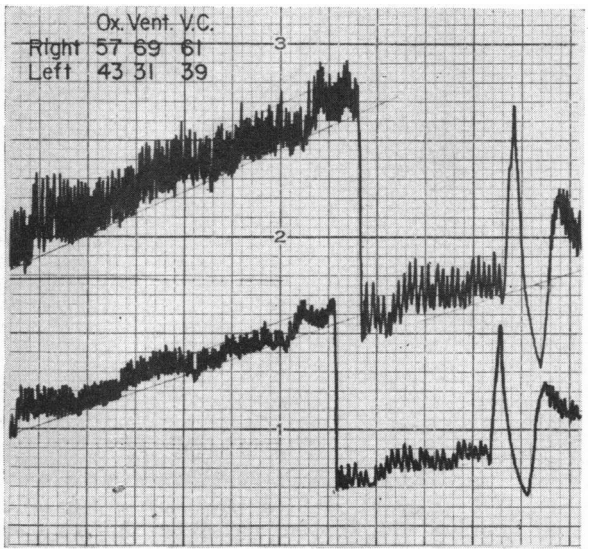

Figure 6 (Case 3).—Bronchospirometric studies show reduced functional oxygen uptake (Ox.) of the left lung (lower tracing and the side affected by the carcinoma) as well as decreased ventilation (Vent.) and vital capacity (VC) expressed in per cent of total for both lungs. But function on the right deemed not sufficiently better than the left to carry the whole load following left pneumonectomy.

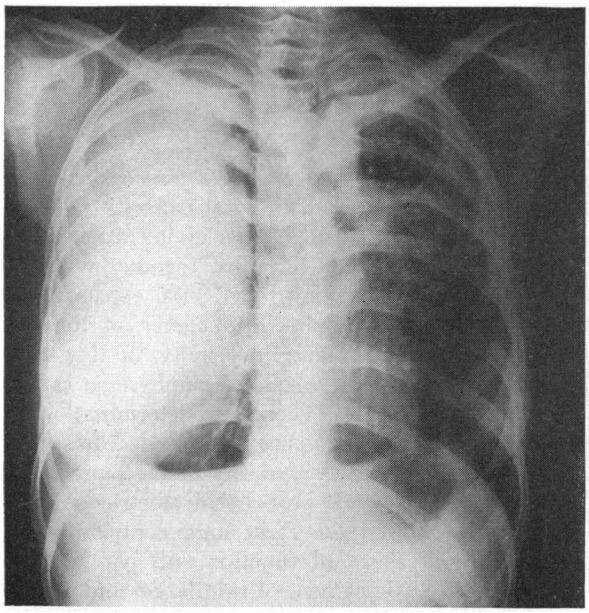

Figure 7 (Case 4).—Old dense pleuritis in right lung, obliterating lung markings, following attempted pneumothorax reexpansion in 1948. Left lung: Old fibrocalcific lesion and pleuritis at left apex and first anterior interspace. New exudative infiltration in area between second and third anterior ribs.

An x-ray film of the chest (Figure 7) showed extensive pleuritis involving most of the right lung with a localized effusion anteriorly placed. There was new infiltration with cavity in the left upper lung in the intraclavicular area.

It was felt that something might be done for the left lung if the right lung were found to be still in good condition beneath the pleuritis. Results of pulmonary ventilatory studies were:

	Predicted	Determined	Per Cent of Predicted
Maximal breathing capacity (liters per minute)	96	51	53
Vital capacity, cubic centimeters (normal timed capacities)	4,020	1,150	35
Air velocity index	1.0	1.51	....
Walking ventilation (liters per minute)	18	24	....
Walking index, per cent (slight dyspnea during walk)	19	45	....

The marginal performance was consistent with a restrictive rather than an obstructive defect. Bron-

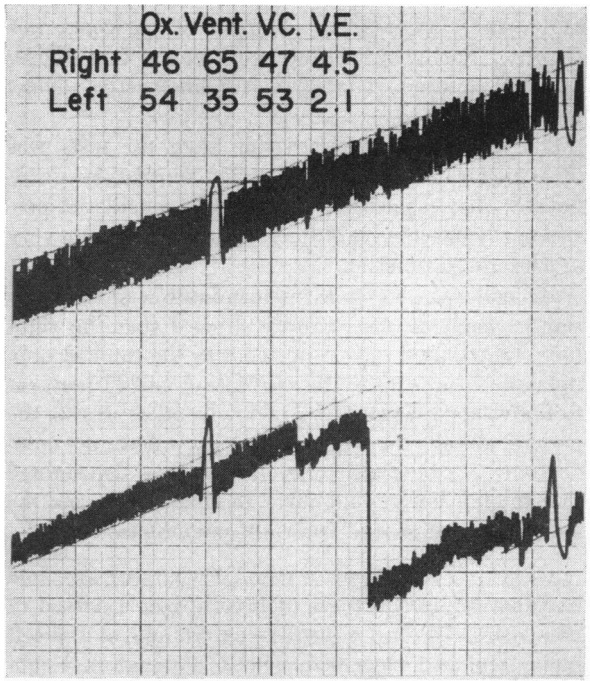

Figure 8 (Case 4).—Bronchospirometry showing better function on the right (upper tracing) beneath the pleuritis than was expected, but with decided restrictive defect as seen in the attempted deep breath of the vital capacity (VC). The left lung (lower tracing) shows better oxygen uptake (Ox.) and vital capacity but poorer ventilation—all expressed in per cent of total for both lungs. VE = Ventilatory equivalent (liters of air ventilated through the lung per 100 cc. of oxygen absorbed).

chospirometry was carried out (Figure 8) to determine the function of the right lung especially. It showed the right lung with surprisingly good function beneath the old pleuritis—oxygen uptake 46 per cent, ventilation 65 per cent and vital capacity 47 per cent. Yet the pulmonary reserve of the right lung was certainly insufficient to sustain life comfortably if function on the left were further diminished by excision or thoracoplasty.

Based on studies of Patton and co-workers,[8] the suggestion was made that a decortication be performed on the right and the patient then be reevaluated. This was done.

Figure 9 shows an x-ray film of the lungs after

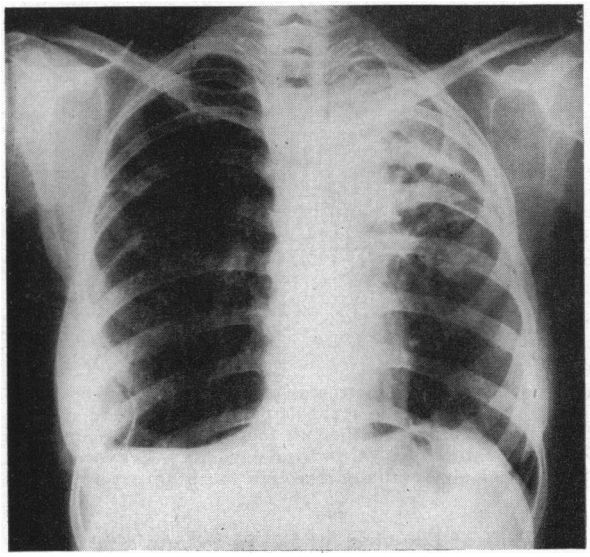

Figure 9 (Case 4).—Following decortication of thickened right pleura, with appearance of a remarkably healthy looking lung. Left lung essentially still unchanged.

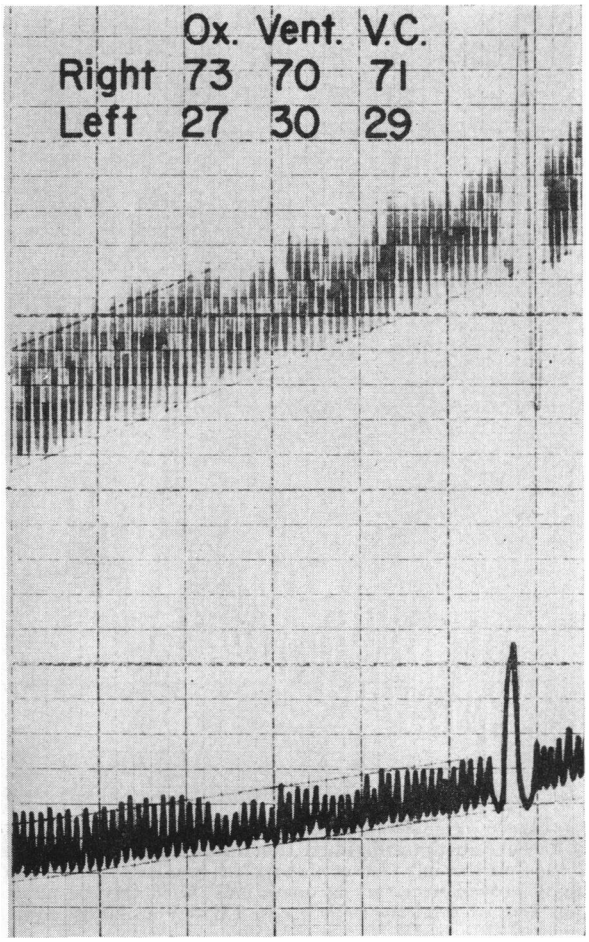

Figure 10 (Case 4).—This spirometric tracing shows excellent recovery of function in the right lung following decortication with loss of restrictive defect as seen in recovery of good ventilation (Vent.) and a good vital capacity (VC). (Ox. = Oxygen uptake—all expressed in per cent of total for both lungs.)

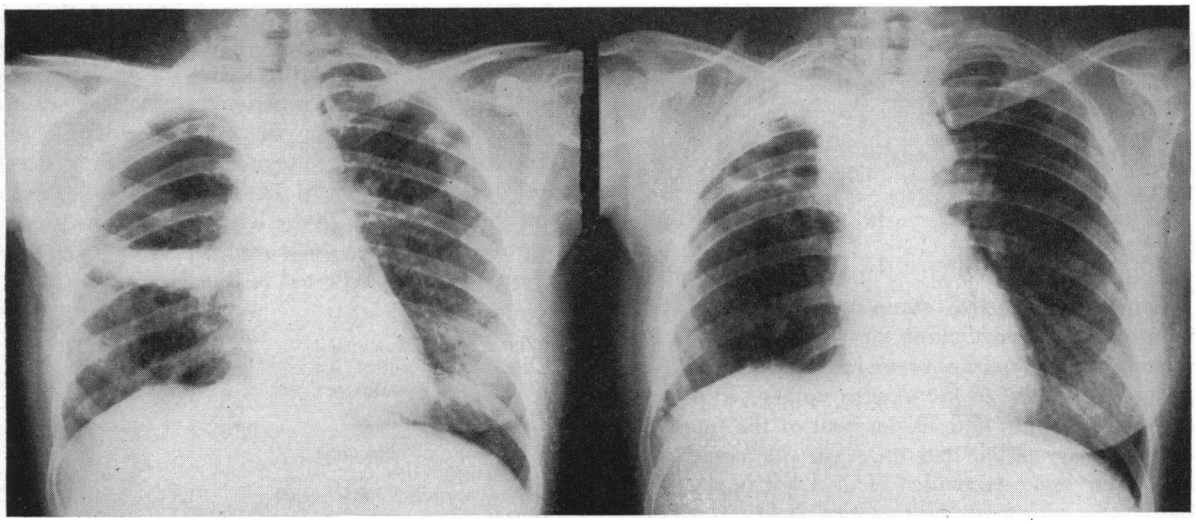

Figure 11 (Case 5).—X-rays before *(left)* and after four months of rest and chemotherapy *(right)*. This shows huge cavity with initial fluid level on the right side and scattered infiltration in left midzone. After four months of treatment there is reduction of cavity size with overexpansion of the right lower lung and decided clearing on the left.

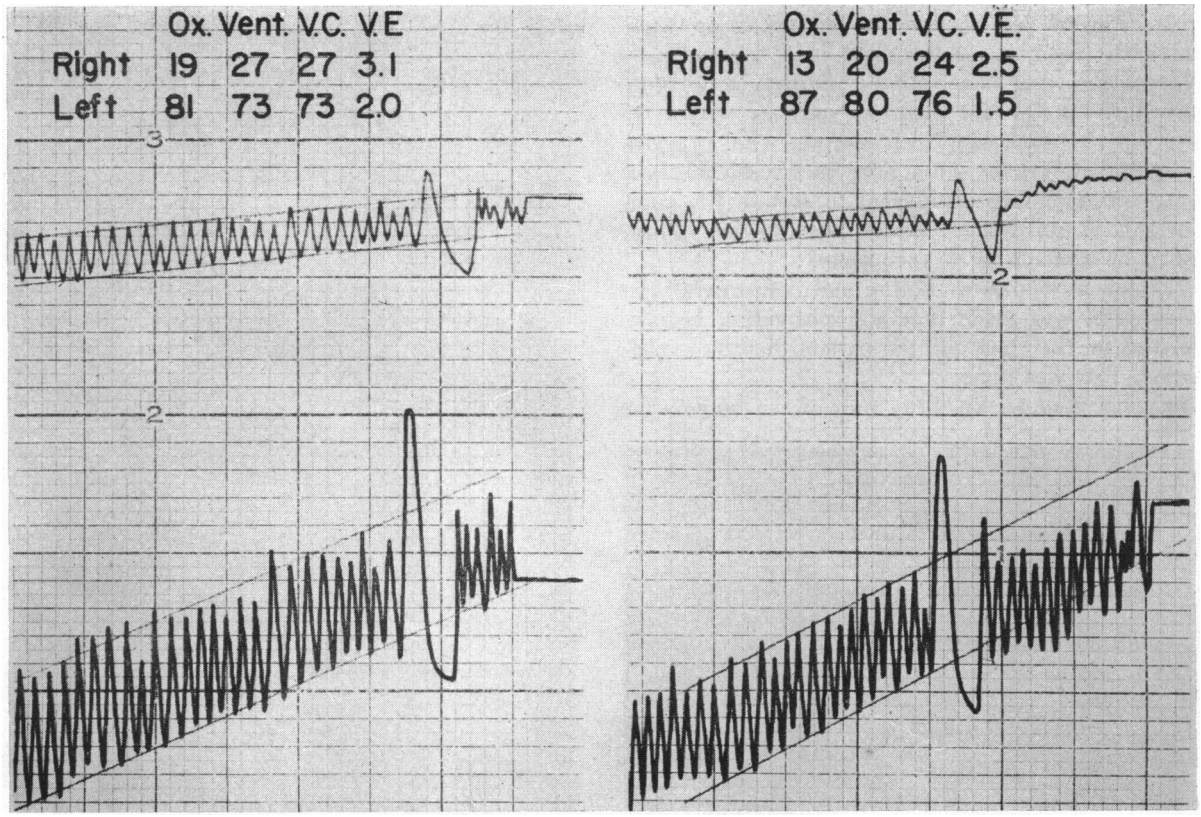

Figure 12 (Case 5).—Bronchospirometry before *(left)* and after four months of treatment *(right)*. Shows very little difference in the individual functional lung reserve, though a little worse on the right (upper tracing) and a little better on the left (lower tracing). It was anticipated that the left lung could carry the full load if a right pneumonectomy proved necessary at operation. Ox. = Oxygen uptake; Vent. = Ventilation; VC = Vital capacity—all expressed in per cent of total for both lungs. VE = Ventilatory equivalent (liters of air ventilated through the lung per 100 cc. of oxygen absorbed).

surgical decortication and wedge resection on the right. The right lung was remarkably clear. Ventilatory studies before and after operation showed improvement of function, as follows:

	Predicted	Before Decortication and Wedge Resection	After Operation
Maximal breathing capacity (liters per minute)	96	51	88
Vital capacity, cubic centimeters (timed capacity was normal)	3,280	1,150	1,800
Air velocity index	1.0	1.5	1.7
Walking ventilation (liters per minute)	16	23	16
Walking index, per cent (no dyspnea walking)	17	45	19

Bronchospirometric studies (Figure 10) seven months after decortication clearly depicted the pronounced functional improvement, the right side carrying 73 per cent of the oxygen uptake, 70 per cent of the ventilation and 71 per cent of the total vital capacity. It was felt that the right side could carry almost any load demanded of it. A left upper lobectomy was carried out without complication or respiratory embarrassment. Thereafter the patient was well and lived a normal life.

The Role of Function Studies in Determining the Extent of Operation

CASE 5. The patient, a tuberculous woman 36 years of age, the mother of a 4-month-old child with tuberculous meningitis, was herself completely free of clinical symptoms. In a comparison of films of the patient's chest before and three months after streptomycin-para-amino salicylic acid therapy along with bed rest, it was noted that a large cavity with a fluid level occupying more than half of the right lung before treatment was greatly reduced after treatment (Figure 11). Infiltration scattered over the midportion of the left lung also was greatly improved. The x-ray improvements from short-term therapy were not reflected in function studies.

	Predicted	Determined Jan. 21, 1952	Determined April 21, 1952
Maximal breathing capacity (liters per minute)	80	33	33
Walking dyspnea index, per cent.	17	40	40
Vital capacity, cubic centimeters	2,760	1,550	1,550
(Per cent in 1 second)	75	58	52
Air velocity index	1.0	0.73	0.73
Residual volume, cubic centimeters	700	.....	540
Residual volume: Total lung capacity ratio, per cent	20	.....	26
Pulmonary mixing index	1.5	.....	0.95

Studies of pulmonary function before and three months after the start of treatment showed marginal overall performance in both instances, with greatly reduced maximal breathing capacity and vital capacity, some slowing of the one-second timed vital capacity consistent with the slight increase of the ratio of residual volume to total lung capacity. This is primarily a restrictive defect without evidence of a minor obstructive element, seen in an air velocity index of 0.73.

Bronchoscopy showed a partially stenosed right upper lobe bronchus and a bent and therefore narrowed right lower lobe bronchus. The left bronchial tree was normal.

Bronchospirometric studies (Figure 12) before and after three months of chemotherapy showed the right lung contributing only 19 per cent of oxygen uptake, 27 per cent of ventilation and vital capacity with a slightly low ventilatory equivalent, that was due probably to the proportionately lower maximal breathing capacity. Here the question that arose was whether only the right upper lobe needed to be excised and the lower and middle lobes could be salvaged for their functional contribution later. At operation, disease was found scattered throughout all lobes on the right. Since the left lung had been shown to be carrying the respiratory functional load without difficulty, right pneumonectomy was found necessary and was carried out. Upon recovery the patient was well and lived a normal life of active work.

CASE 6. A 62-year-old man with far advanced emphysema was seriously incapacitated by dyspnea. An x-ray film showed carcinoma of the esophagus (Figure 13). Pulmonary function studies showed a maximal breathing capacity of 21 per cent of predicted, with a very large vital capacity of 91 per cent of predicted and, therefore, an extremely low air velocity index, indicating serious obstructive emphysema.

In spite of these findings and a recommendation against any transthoracic operation, the surgeon (whose faith in function studies resided chiefly in the vital capacity), noting that the vital capacity was 91 per cent of predicted, proceeded to resect the tumor through the left side of the chest under pentothal-curare-ether anesthesia. The patient died eight hours postoperatively of respiratory failure.

DISCUSSION

Preoperative pulmonary evaluation entails thorough investigation of the inconsistencies between the clinical impression of suitability for operation and the borderline functional reserve where operation is imperative. The area of pulmonary symptomatology unexplained by x-ray examinations and overall clinical estimations of function has been clarified by definitive pulmonary function studies.

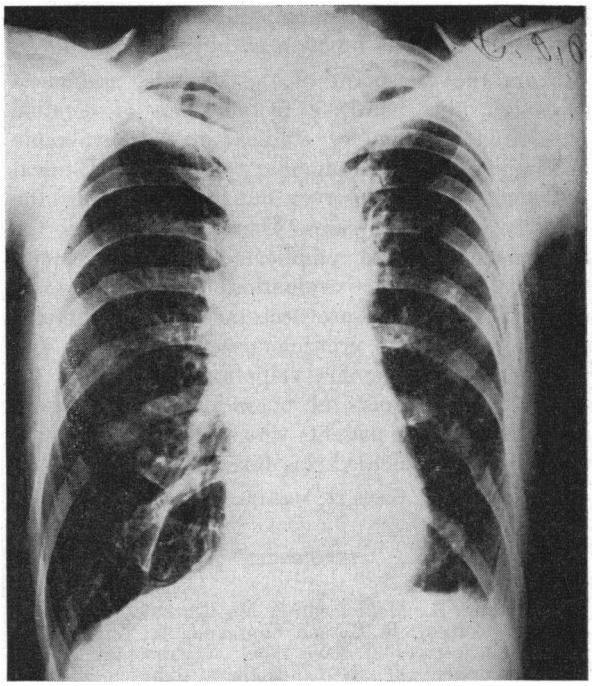

Figure 13 (Case 6).—Proved carcinoma of the esophagus. Upper mediastinal shadow greatly widened with apparent marked emphysema and low irregular diaphragm.

Furthermore, the extent and type of surgical procedure to be planned for the best results, have been, in our experience, greatly influenced by the factual data of overall and individual lung function studies. The patient with good lung function can be evaluated with considerable success by the simpler techniques and by clinical judgment. Careful and searching function studies, however, are of the utmost importance for the patient with borderline pulmonary reserve.

In this latter group the decisions for or against operation are among the most difficult, and no stone in the documentation of pulmonary reserve should be left unturned.

Operation upon "poor risk" patients has been greatly enhanced by the advances in modern chemotherapy as well as in estimating pulmonary function. Middlebrook and co-workers[7] showed this in tuberculosis through newer concepts in drug therapy while advancing the "team concept" of the internist, the bacteriologist, the physiologist and the surgeon in not only preoperative evaluation of the pulmonary status but their cooperation throughout the course of the surgical procedures. Watson and Gaensler,[9] Woodruff[10] and others stressed that the type of pulmonary operation will be influenced by

the degree of disability as well as by the pattern and distribution of function within the lung.[5,6]

From the viewpoint of the internist and chest physician, the definitive factual data of detailed physiologic pulmonary studies are an invaluable aid in preoperative pulmonary evaluation. Clinical judgment alone will screen out the normal and the severely insufficient cases. There are, however, the many borderline and complicated cases that demand the most meticulous evaluation of pulmonary reserve. These studies are necessary in such circumstances not only to prevent operative fatalities and postoperative pulmonary crippling, but also in order that the benefits of operation may be made available to those patients who, on clinical grounds alone, might be denied this form of treatment.

264 Beacon Street, Boston 16, Massachusetts.

REFERENCES

1. Austrian, R., McClement, J. M., Rinzetti, A. D., Donald, K. W., Riley, R. L., and Cournand, A.: Clinical and physiologic features of some types of pulmonary disease with impairment of alveolar-capillary diffusion, Am. J. Med., 2:667, 1951.

2. Gaensler, E. A.: Medical progress. Clinical pulmonary physiology, New Eng. J. Med., 252:177-184, 221-228, 264-271, Feb. 3, 10, 17, 1955.

3. Gaensler, E. A.: Patton, W. E., and Frank, N. R.: Bronchospirometry: VII indications, J. Lab. & Clin. Med., 41:456-477, 1953.

4. Gaensler, E. A.: Analysis of the ventilatory defect by timed capacity measurements, Am. Rev. Tuberc., 64:256-278, 1951.

5. Gaensler, E. A., Cugell, D. W., Lindgren, I., Verstraeten, J. M., Smith, S. A., and Strieder, J. W.: The role of pulmonary insufficiency in mortality and invalidism following surgery for pulmonary tuberculosis, J. Thoracic Surg., 29:163, 1955.

6. Gaensler, E. A., and Strieder, J. W.: Progressive changes of pulmonary function after pneumonectomy, J. Thoracic Surg., 22:1, 1951.

7. Kubral, A. J., Grow, J. B., Middlebrook, G., and Dressler, S. H.: Handling of the poor risk patient with pulmonary tuberculosis: Antimicrobial therapy, cardiopulmonary function and surgery, Dis. Chest, 29:266, 1956.

8. Patton, W. E., Watson, T. R., Jr., and Gaensler, E. A.: Pulmonary function before and at intervals after surgical decortication of the lung, Surg., Gyn. & Obst., 95:477, 1952.

9. Watson, T. R., and Gaensler, E. A.: Immediate and late respiratory impairment due to selective staged thoracoplasty, extraperiosteal plombage and extrapleural conversion thoracoplasty, Tr. Nat. Tuberc. Assn., 48:288, 1952.

10. Woodruff, W., Merkel, C. G., and Wright, G. W.: Decision in thoracic surgery as influenced by the knowledge of pulmonary function, J. Thoracic Surg., 26:156, 1953.